Maryland Department of the Environment (MDE) Per-and Polyfluoroalkyl Substances (PFAS) in Surface Waters and Fish Tissue in Piscataway Creek

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Maryland Department of the Environment
Water and Science Administration

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2.0 ACRONYM LIST

COC	Chain of Custody
DNR	Maryland Department of Natural Resources
EPA	United States Environmental Protection Agency
ESI	Expanded Site Inspection
JBA	Joint Base Andrews
LRP	Land Restoration Program
MDE	Maryland Department of the Environment
M	Meter(s)
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MPH	miles per hour
NAS	Naval Air Station
NAVFAC	Naval Facilities Engineering Command
ng/L	nanograms per liter
NIST	National Institute of Standards and Technology
pps	practical salinity
ppt	parts per trillion
PFAS	Per- and polyfluoroalkyl substances
PFBS	Perfluorobutanesulfonic Acid
PFOS	Perfluorooctanesulfonic Acid
RI	Remedial Investigation
µg/kg	micrograms per kilogram
uS/cm	microSiemens
USGS	United States Geological Survey
WSA	Water and Sciences Administration
°C	degrees Celsius

3.0 EXECUTIVE SUMMARY

Per- and Polyfluoroalkyl Substances (PFAS) are a family of thousands of human-made chemicals that are found in a wide range of products used by consumers and industry since the 1940's. PFAS have been used in a variety of applications including in stain- and water-resistant fabrics and carpeting, cleaning products, paints, and fire-fighting foams due to their resistance to grease, oil, water and heat. Because of the strength of the carbon-fluorine bond, many PFAS are persistent in the environment. Available data on the bioaccumulation potential of certain PFAS indicate that certain PFAS compounds are highly bioaccumulative. The widespread use of PFAS in a variety of products and their ability to remain intact in the environment means that over time PFAS levels from past and current uses can result in increasing levels of environmental contamination which may bioaccumulate throughout the food chain. Understanding the occurrence of PFAS compounds in various environmental compartments (e.g., air, surface water, groundwater, and land) and the routes of human exposure (e.g., in drinking water or in foods such as seafood) is a growing area of science, as environmental and public health professionals seek to better understand the risks to human health posed by PFAS.

In fall 2020, MDE began its effort to sample fish tissue for PFAS by including PFAS analytes in its fish tissue sampling program, which in the fall of 2020, was focused on sampling of fish tissue in the Eastern Shore Region. In late 2020 and early 2021, the Maryland Department of the Environment (MDE) also initiated a targeted study of the occurrence of PFAS compounds in surface water and fish tissue in the Piscataway Creek area. MDE added two fish tissue sample locations in Piscataway Creek for two reasons: there is a known source PFAS at Joint Base Andrews which is located adjacent to the upper reaches of Piscataway Creek, and the area near the mouth of the Piscataway, where it meets the Potomac River, is popular for recreational fishing. MDE was also aware of a discharge of firefighting foam and the resulting fish kill investigation (on July 31, 2020, from Joint Base Andrews) and data concerning PFAS releases to surface water discussed in the 2018 Site Inspection Report of the Fire Fighting Foam usage at Joint Base Andrews, Prince George's County, Maryland (Final Joint Base Andrews SI Report 07 May 2018 (AFFF).pdf).

The Piscataway Creek PFAS study included monitoring for PFAS in surface waters and fish tissue in the tidal and non-tidal waters of Piscataway Creek, and Nanjemoy Creek (a reference site with tidal and non-tidal sampling locations similar to and south of Piscataway Creek with no known PFAS sources). MDE determined that it would be beneficial to sample PFAS levels in surface water and fish tissue in Piscataway Creek to better understand human health risk and potential sources of PFAS. The Department contracted the services of Alpha Analytical Mansfield Laboratory, 320 Forbes Boulevard, Mansfield, MA 02048 for sample analysis of fish tissue and surface water.

The results from the regular fall fish collection in the Eastern Shore Region showed no levels of concern. However, the sampling of fish tissue in Piscataway Creek indicated highly elevated levels of PFAS in fish tissue, in redbreast sunfish.

The non-tidal portion of Piscataway Creek off Commo Road was sampled in the fall of 2020 for a primary trophic level species, yellow- bullhead catfish, and a secondary trophic level species, redbreast sunfish. Both species were collected via electroshock and put into composites of five

same-species fish within a 75% weight gradient. A field blank of non-PFAS water was collected at the time to ensure sampling compliance. The results from the 2020 Fall fish tissue collection in Piscataway Creek identified elevated concentrations of PFOS in sunfish collected west of Rt. 210 in the non-tidal portion of Piscataway Creek off Commo Road. Yellow-bullhead catfish were also collected at the same location and while the results are not as elevated as redbreast sunfish, they are still higher than all other fish tissue results from the fall collection at other sampling stations across the state. The elevated levels of PFOS in redbreast sunfish suggested that further investigation was warranted.

MDE returned to the field in spring 2021 to obtain additional fish tissue and water samples in Piscataway Creek in part to verify/validate the fall 2020 results. Results of the May 2021 PFAS Piscataway Creek sampling were used to assess potential PFAS public health risks from recreational swimming in and consumption of fish from Piscataway Creek. MDE developed risk-based swimming criteria for Perfluorooctanoic Acid (PFOA), Perfluorooctanesulfonic Acid (PFOS) and Perfluorobutanesulfonic Acid (PFBS) and risk-based fish tissue screening criteria for PFOA and PFOS to interpret the sampling results from the perspective of potential risk to human health. Both PFOA and PFOS have EPA-established reference doses (i.e., toxicity values) which were used by EPA to develop EPA's 2016 PFAS Health Advisory for PFOA and PFOS in drinking water. PFOA and PFOS currently have the same EPA reference doses and MDE used these reference doses and the EPA PFBS reference dose to develop its risk-based screening criteria for use in interpreting surface water and fish tissue sampling results.

The tables below summarize the MDE-calculated risk-based screening criteria for PFOA, PFOS and PFBS for both recreational swimming and fish consumption. For fish consumption, human health-based screening concentrations derived for PFOA and PFOS assume individual fish species have uniform fish tissue concentrations throughout the study area. PFOA and PFBS were not detected in any fish tissue samples, therefore MDE's assessment of whether fish tissue levels exceed human health-based screening values is based on a comparison of measured levels of PFOS in fish tissue to human health-based screening values for PFOS in fish.

MDE-calculated risk-based screening criteria for PFOA, PFOS, and PFBS for recreational swimming

Recreational Scenario (All Populations)	**Exposure duration (yrs.)**	**Exposure frequency (days/yr.)**	**Exposure time (hrs. day)**	**Recreational Swimming Screening Concentration PFOA+PFOS/(PFBS) (ng/L)**
Swimming in surface water **moderate**	26	26 (2 days a week, 13 weeks)	2	**17,500/(26,200)**
Swimming in surface water **intensive**	26	52 (2 days a week, 26 weeks)	2	**8,770/(13,100)**

MDE-calculated risk-based screening concentration for PFOS for fish consumption

Population	Consumption Rate (mg-day)	Approximate Meals per Month (8-ounce meal adult, 3-ounce child)	Approximate Meals/Year	Fish Tissue (cooked) Screening Concentration (ug/kg) for PFOS
General Population (76 kg)	29,825	4	48	**73**
Women Child Bearing Age (67 kg)	29,825	4	48	**64**
Children (14.5 kg)	11,185	4	48	**37**

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Summary of Total PFAS and PFOS Sampling Results for Surface Water

Location	Media	Concentration Range (PFAS) (ng/L)	Maximum Concentration PFAS (ng/L)	Maximum Concentration PFOS (ng/L)
Nanjemoy Creek non-tidal	surface water	ND	ND	ND
Nanjemoy Creek tidal	surface water	7	7	3
Piscataway Creek non-tidal	surface water	310 - 3,193	3,193	1,100
Piscataway Creek tidal	surface water	207	207	74

Summary of Total PFAS and PFOS Sampling Results for Fish Tissue

Location	Media	Concentration Range (PFAS) (ug/kg)	Maximum Concentration PFAS (ug/kg)	Maximum Concentration PFOS (ug/kg)
Nanjemoy Creek non-tidal	fish tissue	4 - 10	10	5
Nanjemoy Creek tidal	fish tissue	1 - 6	6	5
Piscataway Creek non-tidal	fish tissue	29 - 247	247	231
Piscataway Creek tidal	fish tissue	4 - 101	101	94

Surface water concentrations of PFAS ranged from not detected in Nanjemoy Creek to 3,193 ng/L (parts per trillion (ppt)) in Piscataway Creek. PFOA plus PFOS and PFBS surface water concentrations were below recreational swimming screening criteria (based on incidental ingestion). PFAS surface water concentrations in Piscataway Creek dissipated with distance as the creek progressed downstream of potential sources at Joint Base Andrews. The concentration of PFAS in the tidal headwaters of Piscataway Creek was 207 ng/L and the dominant PFAS compound throughout Piscataway Creek was PFOS, one of the most persistent, bioaccumulative PFAS compounds. In addition to potential PFAS sources emanating from Joint Base Andrews the Department continues to track down potential sources in the watershed and is working with the Prince George's Fire Department Fire/EMS Training Academy, which is present along Commo Road adjacent to Piscataway Creek, to determine if there are PFAS sources associated with the facility or others in the watershed. Concentrations of PFAS compounds in the nontidal headwaters and tidal headwaters of Piscataway Creek were significantly greater than PFAS surface water concentrations in comparable locations in the Nanjemoy Creek reference site. PFAS surface water concentrations in Piscataway Creek and comparisons to a similar reference site, Nanjemoy Creek, indicate significant likely ongoing sources of PFAS and PFOS exist within the Piscataway Creek watershed.

MDE's evaluation of the fish tissue samples from Piscataway Creek includes a comparison of measured PFOS fish tissue concentrations to measured concentrations at the reference site and to a range of MDE-calculated risk-based site-specific fish consumption screening concentrations. PFBS was not detected in any of the fish tissue samples throughout the study area. These human health-based screening concentrations for PFOS assume that all fish are consumed from the same harvesting location. MDE found that fish tissue concentrations in redbreast sunfish in the non-tidal portion of Piscataway Creek off Commo Road were in excess of the PFOS screening criteria and that fish tissue PFOS concentrations in largemouth bass were in excess of screening criteria in the tidal portion of Piscataway Creek. Fish tissue PFOS concentrations from fish sampled from the Nanjemoy Creek control sites were significantly lower than fish tissue PFOS concentrations in fish sampled from Piscataway Creek. Results of the fish tissue consumption evaluation for PFOS indicated consumption of fish tissue within non-tidal and tidal portions of the Piscataway Creek study area are in excess of the MDE site-specific fish consumption screening criteria. Fish tissue collection and assessment activities in and around Piscataway Creek are ongoing and additional information regarding advisories or assessment activities based on the results will be provided as they become available.

The study concludes that PFOA, PFOS and PFBS are present in the non-tidal and tidal waters of Piscataway Creek at concentrations below risk-based recreational use swimming screening criteria, but PFAS surface water concentrations in both the non-tidal and tidal portions of Piscataway Creek are significantly greater than PFAS concentrations when compared to the Nanjemoy Creek reference sites. Moreover, PFOS are present in fish tissue at levels that exceed human consumption-based screening criteria and fish consumption advisories and additional assessment may be warranted in both the tidal and non-tidal waters of Piscataway Creek.
The results and conclusions from this study will be used by MDE to determine the need for more immediate risk reduction actions, such as the issuance of fish advisories. In addition, the study results will be used by MDE in PFAS source tracking efforts and associated risk management actions to address uncontrolled releases.

[1] *Fish consumption screening concentration derivations within the MDE Fish and Shellfish Program include a 30 % reduction in contaminant concentration in the fish due to trimming and cooking losses.*

4.0 INTRODUCTION

The Maryland Department of the Environment's (MDE) Water and Sciences Administration (WSA) conducted this monitoring effort to assess the occurrence of Per- and Polyfluoroalkyl Substances (PFAS) in surface water and fish tissue in and around Piscataway Creek, Prince George's County, to assess any potential human health risks. The Department collected samples from surface water and fish tissue in and around the tidal and non-tidal waters of Piscataway Creek and within control reference sites in tidal and non-tidal waters of Nanjemoy Creek. Sampling locations were targeted to focus on primary potential source areas and potential areas of concern (AOC) associated with Joint Base Andrews (JBA) and the Prince George's County Multi Agency Training Center (including fire fighters). Results and evaluations of the sample data collected during this investigation were compared to applicable state and federal risk-based concentration levels or site and media specific risk-based screening levels derived for the protection of human health are presented below.

5.0 STUDY AREA AND BACKGROUND

MDE initiated the 2021 study of PFAS levels in surface water and fish tissue from fish in Piscataway Creek for two reasons: (1) there is a known source of PFAS at Joint Base Andrews which is located adjacent to the upper reaches of the Piscataway Creek watershed and (2) this area is a popular area for recreational fishing. Following a discharge of firefighting foam and the resulting fish kill investigation on July 31, 2020, from Joint Base Andrews and a review of the 2018 Site Inspections Report of the Fire Fighting Foam usage at Joint Base Andrews, Prince George's County, Maryland (Final Joint Base Andrews SI Report 07 May 2018 (AFFF).pdf), MDE decided to focus on an assessment of the human health risks associated with PFAS in Piscataway Creek.

The results from the fall fish tissue collection in Piscataway Creek (Table 2) show elevated concentrations of PFAS in sunfish collected west of Rt. 210 in the non-tidal portion of Piscataway Creek. Yellow-bullhead catfish were also collected at the same location and while the results were not as elevated as redbreast sunfish, they are still higher than all other fish tissue results from the fall collection at other sampling stations across the state. This suggested that further investigation was warranted. The Piscataway Creek collection in the fall was repeated in Spring 2021 to confirm the elevated PFAS in sunfish and catfish tissue and explore PFAS occurrence in other species found in the area but not previously collected in the fall.

Piscataway Creek is a small tributary of the Potomac River located in Prince George's County. The potential sources of PFAS to the creek include JBA and a multi-agency training center (including fire fighters). The 2018 Site Inspections Report of Fire Fighting Foam Usage at Joint Base Andrews shows relatively high levels of PFOA and PFOS in surface waters and storm water near or on the base. An assessment of pollution sources provided by MDE Water Supply Program directed the placement of sampling stations based on discharge from previously listed areas of concern; no other major sources of PFAS were identified (Figure 1 and 2).

Recreational fishing is most popular within the tidal portion of Piscataway Creek where it meets the Potomac River. There is little access to deep pools in the non-tidal portions of the creek and

the upstream portions are quite shallow in most places. After consulting with the Maryland Department of Natural Resources (DNR), MDE determined that the 8.5 mile stretch of the tidal portion is popular for yellow perch, particularly in the Spring. According to the DNR, other popular species include largemouth bass and sunfish from the deep pools. There is limited public access to these areas of Piscataway Creek from the shoreline, as they are bordered by private property. The communities in this area were evaluated using the draft MDE EJ Screening Tool (Appendix 6) and MDE found that there were no environmental justice implications.

5.1 PFAS Basic Information and Study Target Analyte List

PFAS refers to a large group of human-made chemicals that for decades were used in a range of products, including stain- and water-resistant fabrics and carpeting, cleaning products, paints, cookware, food packaging and fire-fighting foams. Because of the strength of the carbon-fluorine bond, some PFAS can last a long time in the natural environment and can potentially accumulate in the food chain. Scientific studies suggest that certain PFAS may have adverse impacts on human health. Measuring PFAS concentrations in drinking water and food, estimating dietary exposure and completing quantitative risk assessments to estimate human health risk is a relatively new area of science. For example, EPA used quantitative risk assessments to develop its 2016 health advisory levels for PFOA and PFOS in drinking water. For additional information provided by the federal government on PFAS, see the following links:

- EPA Website for PFAS
- https://www.atsdr.cdc.gov/pfas/docs/pfas_fact_sheet.pdf
- https://www.fda.gov/food/chemicals/questions-and-answers-and-polyfluoroalkyl-substances-pfas-food

MDE is putting a priority on better understanding, communicating, and reducing unacceptable risks to human health related to PFAS. This includes identifying and investigating PFAS occurrence in areas with the potential for the highest relative risk such as public drinking water treatment facilities that may be more vulnerable to contamination, in locations where there may be more than one source of PFAS releases. The focus of this study is to quantify and assess the presence of PFAS in surface water and fish tissue and throughout the study area. The Target Analyte List (TAL) of PFAS compounds utilized in this study included 14 PFAS analytes (Table 1).

6.0 SAMPLING PROCEDURE AND ANALYTICAL METHODOLOGY

6.1 Surface Water Sample Collection

6.1.1 Surface Water Sampling

Surface water samples were collected on May 14th and 18th of 2021 in and around the non-tidal and tidal waters of Piscataway creek and the reference sites in the tidal and non-tidal waters of Nanjemoy Creek south of Piscataway Creek. Figures 1 and 2 show the sampling locations for surface water and fish tissue sample stations throughout the tidal and non-tidal waters of

Piscataway Creek and the tidal and non-tidal waters of Nanjemoy Creek. The Nanjemoy Creek sites were used as a reference site or control throughout the study.

Each of four teams was provided with a trip blank that was stored in their vehicle in a cooler on ice the day of sampling. Trip blanks were inserted in the cooler at the beginning of the day and traveled to the boat launch location and back to the Annapolis Field Office for courier pickup. A total of 10 field blanks containing PFAS-free water supplied by the contract laboratory were utilized during sampling using the same methodology detailed in previous studies (provide reference to previous studies). The number of samples, sample locations and quality control samples are detailed in Table 4. The samples were shipped to the laboratory following approved sample handling and storage methods. Chain of custody forms were utilized to properly track sample handling, requested analytical tests and sample transfer (Appendix 1).

6.2 Fish Tissue Sample Collection- Piscataway Creek and Nanjemoy Creek

The Department collected fish tissue samples at two locations in the tidal and non-tidal waters of Piscataway Creek (Figure 1). Additionally, fish tissue samples were collected from two locations in the tidal and non-tidal waters of the Nanjemoy Creek (Figure 2) reference site. All samples collected were submitted for analysis to determine the levels of 14 PFAS. Corresponding analytical methodologies and quality control procedures are detailed and provided in Appendix 3.

On May 14, 2021, May 17, 2021, May 20, 2021, and May 26, 2021, the Department collected fish tissue samples at four sampling locations: the tidal headwaters of Piscataway Creek (5/14/2021), the non-tidal waters of Piscataway Creek at Commo Road (05/17/2021), the tidal headwaters of Nanjemoy Creek (05/20/2021), and the non-tidal waters of Nanjemoy Creek (05/26/2021). Collections are usually accomplished using a boat-mounted electrofisher powered by a 3.5- or 5.0-Kilowatt generator. Fillet composite samples consist of one fillet from each of five fish of the same species. The minimum wet weight composite necessary for analyses is 10 grams. The minimum number of fish comprising a composite sample is five fish. For all samples, the smallest fish in the sample must be within seventy-five percent of the total length of the largest fish in the composite sample.

Filet knives used for cleaning fish were rinsed with PFAS-free water each time before fileting the next sample. Filets were placed directly in the laboratory supplied containers, bagged, and placed on ice. Each of the four teams was provided a trip blank by the laboratory containing PFAS free water and a field blank for each of the collection sites. Methodology and rationale behind the use of trip and field blanks was the same as mentioned previously. Once complete, all trip and field blanks were bagged and placed in their designated cooler for shipment and analysis by Alpha Analytical Laboratory. Fish tissue samples were transported to and homogenized at the contract laboratory. At each station, environmental conditions and water quality parameters were collected and recorded on field data sheets. These data for this sampling event can be found in Appendix 1 and Appendix 2.

6.3 Analytical Methodology

The TAL suite consists of 14 PFAS analytes (See Table 1 identifying the PFAS TALs and Appendix 3 for approximate method detection limits for water and fish tissue). A brief narrative of the sample preparation and analytical methodology for both surface water and fish tissue analysis are presented in Appendix 3. Given the lack of standardized, published analytical methods for non-drinking water sample media, and the fact that EPA 500 series methods are not allowed to be modified, an alternative method based on principles detailed in the EPA 500 series method was utilized by the contract laboratory. The Alpha Analytical method was a liquid chromatography tandem mass spectrometry method (LC/MS/MS) with solid phase extraction, and it is most similar to Method 533 in that it utilizes the weak anion exchange (WAX) SPE cartridge, and the method calibration employs the isotope dilution technique. This method incorporates the maximum number of commercially available extracted internal standards, consisting of (18) 13C-enriched and (2) 2H-enriched compounds. Up to 36 PFAS compounds, or any subset, can be quantified using this approach. The method can analyze a wide range of sample matrices in addition to aqueous samples including soils/sediments, biosolids, and tissues. Although similar methods are used, there is currently no standard analytical method, from EPA or any voluntary consensus standard body, for PFAS analysis in fish tissue. Few laboratories advertise fish tissue analysis for PFAS.

7.0 PFAS "STANDARDS", TOXICITY VALUES AND UNCERTAINTY ANALYSES

Health-based guidance values in specific environmental media for some PFAS have been developed by federal, state, and international agencies using a variety of critical studies, endpoints, methods, and policy choices. This study focuses specifically on assessing human health risk associated with measured levels of PFOA, PFOS and PFBS in surface water, and PFOS in fish taken from Piscataway Creek. PFOS was the predominant PFAS detected in fish tissue and the only detected PFAS with peer reviewed toxicity values, therefore, fish tissue consumption risks were evaluated only for PFOS. MDE used peer reviewed reference doses (RfDs) for PFOA and PFOS which were developed by EPA (and used by EPA in developing its 2016 Drinking Water Health Advisory Levels) and an MDE estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime (with uncertainty factors generally applied to reflect limitations of the data used). The PFBS RfD was a Provisional Peer-Reviewed Toxicity Value (PPRTV) primarily derived for use in EPA's Superfund Program. RfDs are generally used in noncancer health assessments and the RfDs utilized in this assessment are approved by EPA and detailed within the Regional Screening Level User's Guide, (May, 2021), https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide. The MDE-developed health-based guidance values for swimming and for fish consumption are estimates of a daily exposure dose that is not expected to lead to a non-cancer health risk over a set period. These guidance values are used to identify exposures (and levels in surface water and fish) that could potentially pose an unacceptable risk to human health. However, exposure above a guidance value does not mean that health problems will occur. MDEs quantitative assessment addresses only Perfluorooctanoic acid (PFOA) Perfluorooctanesulfonic acid (PFOS) and Perfluorobutanesulfonic Acid (PFBS), three of the most studied PFAS which both have RfDs.

The MDE risk threshold for noncarcinogens is set at a hazard quotient of 1 which is the ratio of the potential exposure to a substance and the level at which **no** adverse effects are expected (calculated as the exposure divided by the appropriate chronic or acute value) which means adverse noncancer effects are unlikely at this level, and thus can be considered to have negligible risk. For hazard quotients greater than 1, the potential for adverse effects increases, but we do not know by how much. For toxics that affect the same target organ or organ systems that can cause similar adverse health effects, combining hazard quotients from different toxics is often appropriate. The sum of hazard quotients is a hazard index (HI) which was utilized for PFOA, PFOS and PFBS in this evaluation. An HI of 1 or lower means toxics are unlikely to cause adverse noncancer health effects over a lifetime of exposure. However, an HI greater than 1 doesn't necessarily mean adverse effects are likely.

As stated previously PFAS compounds have been in use since the 1940s and PFAS are found in a wide array of consumer and industrial products. Other than for PFOA, PFOS and PFBS, the vast majority of PFAS compounds in the marketplace have little to no toxicity information or RfDs. As greater knowledge of the toxicity of other PFAS compounds advances, MDE will re-visit prior assessments to ensure that appropriate actions are taken to address any unacceptable human health risk. Currently, the MDE, EPA and other organizations are collaborating to generate and review research and consider new scientific information as it becomes available on the bioaccumulation potential and toxicity of additional PFAS. Developing toxicity values or oral reference doses, RfDs, for other PFAS, including GenX chemicals are a priority for EPA and will be considered by MDE as the research becomes available. Accordingly, the uncertainty concerning the human health risks associated with other PFAS detected in this study is discussed qualitatively.

7.1 Surface Water Data

Surface water sample results are presented in Table 5 and corresponding sample locations are identified in Figures 1 and 2. The surface water PFAS concentrations from the reference sites in Nanjemoy Creek (Figure 2) ranged from not detected in the non-tidal headwaters to 6.77 ng/L in the tidal headwaters. The results within Piscataway Creek ranged from 207 ng/L in the tidal headwaters prior to its discharge into the Potomac River to as high as 3,193 ng/L total PFAS in the non-tidal headwaters along Colonial Lane just south of Joint Base Andrews. PFAS concentrations exhibited a dilution attenuation pattern dissipating with distance as the creek progressed downstream of potential sources originating from Joint Base Andrews. In addition to potential PFAS sources at Joint Base Andrews the Prince George's Fire Department Fire/EMS Training Academy is present along Commo Road adjacent to Piscataway Creek, however, the presence of PFAS sources associated with the facility is not known. All surface water samples taken from Piscataway Creek had PFAS levels greater than samples taken from comparable reference sites in Nanjemoy Creek.

7.1.1 Recreational Surface Water Risk-Based Screening Evaluation

MDE calculated the levels of PFOA plus PFOS and PFBS in Piscataway Creek which would pose an unacceptable level of risk to recreational swimmers (through accidental ingestion of water while swimming) to compare these levels to measured levels of PFOA plus PFOS and

PFBS in Piscataway Creek. If measured levels of PFOA plus PFOS or PFBS are in excess of MDE's calculated human health recreational swimming screening values, MDE would find that swimming in Piscataway Creek would pose unacceptable risks to human health. Recreator surface water exposure supporting calculations, equations and exposure variables are presented in detail in Appendix 4 and Appendix 5. Surface water exposure was evaluated for all potential populations including children at all stages of development from birth on. Recreational use surface water exposures were evaluated using a conservative range of exposure times within the study area as presented in Table 1 below.

Table 1: Site-specific Surface Water Exposure Variables

Recreational Scenario (All Populations)	**Exposure duration (yrs.)**	**Exposure frequency (days/yr.)**	**Exposure time (hrs. day)**	**Recreational Swimming Screening Concentration PFOA+PFOS/(PFBS) (ng/L)**
Swimming in surface water **moderate**	26	26 (2 days a week, 13 weeks)	2	**17,500/(26,200)**
Swimming in surface water **intensive**	26	52 (2 days a week, 26 weeks)	2	**8,770/(13,100)**

The recreational exposure pathway MDE assessed is incidental ingestion of water while swimming, wading, or recreating in surface water. Water intake rates varied with age and exposure time and were estimated to be as high 125 milliliters per hour for children. Dermal contact with surface water was not quantitatively evaluated as a pathway of exposure due to the expected low dermal permeability of PFOA, PFOS and PFBS. Inhalation of PFOA, PFOS and PFBS was also not considered as an important pathway of exposure for swimmers.
Surface water concentrations of PFAS are presented in Table 5. Calculations of site-specific surface water risk-based swimming screening values are presented in Appendix 4 and Appendix 5. Risk-based surface water screening concentrations for swimming are greater than EPA recommended health advisory levels for PFAS in drinking water because people accidently ingest much less water per day while swimming or recreating as compared to the amount of water people purposefully ingest in drinking water throughout the day. Comparisons of surface water concentrations to the EPA recommended Health Advisory Level (or any other drinking water criteria) are not appropriate for assessing swimming risk. MDE conservatively derived surface water recreational screening criteria for the Piscataway Creek study area utilizing screening criteria that may not be applicable for certain portions of Piscataway Creek due to limiting factors like water depth and the low probability of swimming within the upper reaches of the creek closer to potential sources.

As presented in Table 7 the maximum detected surface water concentration of 3,193 ng/L was significantly below the risk-based recreator screening concentrations for moderate (17,500 ng/L) and intensive (8,770 ng/L) surface water recreator exposures for the sum of PFOA and PFOS and the risk-based recreator screening concentrations for PFBS moderate (26,200 ng/L) and intensive (13,100 ng/L) recreator exposure to surface waters throughout the Piscataway Creek study area. The maximum PFAS concentration for the reference site in the tidal and non-tidal portions of

Nanjemoy Creek was 6.77 ng/L which is significantly lower than the risk-based recreator screening criteria and the PFOA plus PFOS and PFBS results for the Piscataway Creek study area. PFAS compounds, including PFOA and PFOS, were only intermittently detected at or near the analytical detection limits in the Nanjemoy Creek reference sites. The concentration of PFAS in the tidal headwaters of Piscataway Creek was 207 ng/L and the dominant PFAS compound throughout Piscataway Creek was PFOS, one of the most persistent, bioaccumulative PFAS compounds. In addition to potential PFAS sources emanating from Joint Base Andrews the Department continues to track down potential sources in the watershed and is working with the Prince George's Fire Department Fire/EMS Training Academy which is present along Commo Road adjacent to Piscataway Creek to determine if PFAS sources associated with the facility or others in the watershed are known.

Based upon the results of the recreational swimming exposure evaluation, surface water recreational exposure risk estimates based on measured values in Piscataway Creek are below MDE site-specific recreational use (swimming) screening criteria.

7.2 Fish Tissue Data

Fish tissue results are presented in Table 6 and corresponding sample locations are identified in Figures 1 and 2. PFOS as well as other PFAS compounds were detected above the reported detection limits in all samples from Piscataway Creek as well as the Nanjemoy Creek reference sites. PFOA and PFBS were not detected in any of the fish tissue samples analyzed in this study, therefore, human health risks from consumption of fish with detected concentrations of PFOS was the only PFAS compound evaluated quantitatively.

7.3 Fish Consumption Screening Evaluation

MDE evaluated detected concentrations of PFOS in fish tissue to determine whether measured values exceed human health risk screening levels based on fish consumption as the pathway of exposure. Fish consumption supporting calculations, equations and exposure variables are presented in detail in Appendix 4 and Appendix 5. MDE quantitatively evaluated human health risk through fish consumption using EPA and MDE recommended fish consumption exposure variables. These include the use of a range for the number of fish meals per year and an assumption that each meal consists of an 8-ounce serving for adults and 3-ounce servings for children. The assessment quantitatively evaluated exposure assuming fish consumed were all from the same location and the same species within the study area. These assumptions likely over-estimate potential health risk.

MDE included derivation of fish consumption advisories for the general adult population, children, and child-bearing women in this assessment. EPA CERCLA guidance may not include these sub-populations in site-specific assessments. The inclusion of children and child-bearing women follows guidelines for recreationally caught fish in Maryland utilized in the MDE Fish and Shellfish Monitoring Program (https://mde.maryland.gov/programs/marylander/fishandshellfish/pages/fishconsumptionadvisory.aspx). The screening criteria are site-specific and should not be considered as screening criteria for commercially harvested fish. Commercially available fish often come from a range of

locations and suppliers and this study was not intended to specifically provide guidance on commercially harvested fish.

Site-Specific Fish Consumption Screening Concentrations

Population	Consumption Rate (mg-day)	Approximate Meals per Month (8-ounce meal adult, 3-ounce child)	Approximate Meals Per Year	Fish Tissue (cooked) Screening Concentration (ug/kg) for PFOS
General Population (76 kg)	59,650	8	96	37
Women Child Bearing Age (67 kg)	59,650	8	96	33
Children (14.5 kg)	22,370	8	96	19
General Population (76 kg)	29,825	4	48	73
Women Child Bearing Age (67 kg)	29,825	4	48	64
Children (14.5 kg)	11,185	4	48	37
General Population (76 kg)	7,456	1	12	291
Women Child Bearing Age (67 kg)	7,456	1	12	257
Children (14.5 kg)	2,796	1	12	149

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Derivation of site-specific fish tissue risk-based screening values are presented above and detailed in Appendix 4 and Appendix 5. As presented in Table 6, PFAS was detected in fish tissue and the comparisons to the risk-based site-specific screening criteria for PFOS were in excess of risk-based fish consumption screening concentrations for PFOS for multiple potential exposure scenarios and consumption rates for the largemouth bass and most exposure scenarios for redbreast sunfish in the Piscataway Creek Study area. Consumption of yellow bullhead catfish exceeded high intensity (96 meals per year) fish consumption rates for children in the upper reaches of Piscataway Creek, however, fish size, habitat, and probability of catching and consuming yellow bullhead catfish at the consumption rates utilized to derive fish tissue screening concentrations is low within this portion of Piscataway Creek. Fish tissue concentrations of PFOS were less than the site-specific health-based consumption screening criteria for all exposure scenarios for the blue catfish in the tidal headwaters of Piscataway Creek. Although concentrations of PFOS were detected in all fish species tested within the Nanjemoy Creek reference sites the concentrations were below all the site-specific health-based consumption screening criteria. PFOS fish tissue concentrations in the Nanjemoy Creek reference site were less than the PFOS fish tissue concentrations for the equivalent species within the Piscataway Creek study area.

[1] *Fish consumption screening concentration derivations within the MDE Fish and Shellfish Program include a 30 % reduction in contaminant concentration in the fish due to trimming and cooking losses.*

7.4 Ecological Screening Evaluation

The primary objectives of this pilot study were to evaluate human health-related risks associated with PFAS in the surface water and fish within Piscataway Creek. The EPA has not issued Clean Water Act (CWA) 304(a) recommended ambient water quality criteria for any PFAS compounds (including PFOA, PFOS and PFBS), although work is underway to develop values to protect ecological health. In this study total PFAS concentrations ranged from not detected to 3,193 ng/L which is approaching some of the limited published ecological aquatic life screening criteria. A white paper published by the Florida Department of Environmental Protection in 2020 has a reported freshwater chronic ecological surface water screening concentration of 37,000 ug/L and the State of Michigan published aquatic life water quality value is 140,000 ng/L for PFOS. The acute and chronic impacts to aquatic life and the ability of certain PFAS compounds to accumulate up the food chain are important factors that are being assessed as recommended aquatic life water quality criteria are being developed by EPA. MDE will revisit the issue of ecological impacts associated with these measured levels in Piscataway Creek when EPA completes its work and issues CWA 304(a) ambient water quality criteria for aquatic life protection.

8.0 CONCLUSIONS

The MDE WSA in cooperation with Maryland's DNR conducted this study to assess the occurrence of Per- and Polyfluoroalkyl Substances (PFAS) in surface water and fish tissue in and around Piscataway Creek and a reference site in the tidal and non-tidal portions of Nanjemoy Creek along the Potomac River. Sampling locations were targeted to focus sampling in potential areas of concern associated with known or highly likely sources of PFAS release.
Results of MDE's public health risk evaluation for recreational swimming indicate that measured concentrations of PFOA, PFOS and PFBS in Piscataway Creek (and the Nanjemoy reference site) are below the risk-based screening concentrations for both moderate and intensive swimming. Surface water concentrations of PFAS ranged from non-detect to 7 ug/L in the Nanjemoy Creek reference stations and from 207 to 3,193 ng/L in the Piscataway Creek study area. The screening values are 17,500 ng/L for PFOA+PFOS and 26,200 ng/L for PFBS for moderate use swimming and 8,770 ng/L for PFOA+PFOS and 13,100 ng/L for PFBS for intensive use swimming. Concentrations of PFAS were significantly greater in the Piscataway Creek area relative to the Nanjemoy Creek reference stations indicating the presence of sources of PFAS within the Piscataway Creek study area.

PFAS surface water concentrations in Piscataway Creek dissipated with distance as the creek progressed downstream of potential sources at Joint Base Andrews. The concentration of PFAS in the tidal headwaters of Piscataway Creek was 207 ng/L and the dominant PFAS compound throughout Piscataway Creek was PFOS, one of the most persistent, bioaccumulative PFAS compounds. In addition to potential PFAS sources emanating from Joint Base Andrews the Department continues to track down potential sources in the watershed and is working with the Prince George's Fire Department Fire/EMS Training Academy, which is present along Commo Road adjacent to Piscataway Creek, to determine if there are other PFAS sources associated with the facility or others in the watershed.

Results of the PFAS public health risk evaluation for fish consumption identified fish tissue concentrations of PFOS in excess of risk-based fish consumption screening concentrations for multiple potential exposure scenarios and consumption rates for the largemouth bass and most exposure scenarios for redbreast sunfish in the Piscataway Creek Study area. Consumption of yellow bullhead catfish exceeded high intensity (96 meals per year) fish consumption rates for children in the upper reaches of Piscataway Creek, however, fish size, habitat, and probability of catching and consuming yellow bullhead catfish at the consumption rates utilized to derive fish tissue screening concentrations is low within this portion of Piscataway Creek. Fish tissue concentrations of PFOS were less than the site-specific health-based consumption screening criteria for all exposure scenarios for blue catfish in the tidal headwaters of Piscataway Creek. PFAS was detected in all fish species tested within the Nanjemoy Creek reference sites; however, the concentrations were below all the site-specific health-based consumption screening criteria and the PFOS fish tissue concentrations in the Nanjemoy Creek reference site were significantly less than the PFOS fish tissue concentrations for the equivalent species within the Piscataway Creek study area.

Given the use of PFAS compounds throughout the marketplace, their bioaccumulative properties and the uncertainty associated with their potential presence in environmental media throughout Maryland, MDE efforts regarding PFAS compounds impacts to human health and the environment are ongoing and evolving rapidly. Actions are underway at both the federal level (EPA, DOD, USGS) and the state level to better understand PFAS risk and exposure pathways and to reduce as needed the presence and potential exposure to PFAS compounds both environmentally and within the marketplace. Investigative efforts at Department of Defense Facilities, including Joint Base Andrews, as well as other public and private potential sources of interest in and around Piscataway Creek and the Potomac River are ongoing. As additional environmental and human health assessment information is derived regarding PFAS compounds, MDE will pursue updates to its strategy and action plan to ensure protection of public health and natural resources in Maryland. Updates regarding fish consumption advisories and investigations in the Piscataway Creek area of the Potomac watershed may be found at the MDE PFAS Landing Page (https://mde.maryland.gov/PublicHealth/Pages/PFAS-Landing-Page.aspx).

At the time of this publication MDE is collecting additional fish tissue samples within the Potomac River to assess potential health risks associated with PFAS in areas of concern where Piscataway Creek discharges to the Potomac. Known PFAS current and potential historic users within the Piscataway Creek drainage basin have been contacted and efforts to characterize, assess and mitigate identified releases that may be impacting public health and the waters of the state are ongoing.

9.0 REFERENCES

EPA, Regional Screening Levels (RSLs) User's Guide, May 2020, https://www.epa.gov/risk/regional-screening-levels-rsls-users-guide.

EPA (2000a). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 1. Fish Sampling and Analysis. In (doi: EPA 823-B-00-0073rd ed.

EPA (2000b). Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories. Volume 2. Risk Assessment and Fish Consumption Limits. In (doi: EPA 823- B-00-0083rd ed.

https://floridadep.gov/sites/default/files/Draft-PFOA-PFOS-Eco-White-Paper.pdf

https://www.michigan.gov/documents/mdhhs/PFAS_-_Overview_of_Michigan_Values_FINAL_675761_7.pdf

10.0 TABLES AND FIGURES

Table 1: Target Analyte List

Parameter	Acronym	CAS Number
Perfluorobutanesulfonic Acid	PFBS	375-73-5
Perfluorohexanoic Acid	PFHx A	307-24-4
Perfluoroheptanoic Acid	PFHpA	375-85-9
Perfluorohexanesulfonic Acid	PFHxS	355-46-4
Perfluorooctanoic Acid	PFOA	335-67-1
Perfluorononanoic Acid	PFNA	375-95-1
Perfluorooctanesulfonic Acid	PFOS	1763-23-1
Perfluorodecanoic Acid	PFDA	335-76-2
N-Methyl Perfluorooctanesulfonamidoacetic Acid	NMeFOSAA	31506-32-8
PerfluorouND1ecanoic Acid	PFUnA	2058-94-8
N-Ethyl Perfluorooctanesulfonamidoacetic Acid	NEtFOSAA	1691-99-2
Perfluorododecanoic Acid	PFDoA	16517-11-6
Perfluorotridecanoic Acid	PFTrDA	72629-94-8
Perfluorotetradecanoic Acid	PFTA	376-06-7

Table 2: PFAS Samples in Fall 2020 Piscataway Creek (ug/kg)

Location	Position	Collection Reference	Site Reference	Sample ID	Sample Type	Field Blanks	Avg Length (cm)	Avg Weight (g/lbs.)	Collection Date
Commo Road - Non Tidal	38.74776, -76.84507	Composite Species 1 - Yellow Bullhead Catfish	PIS0134	2020FTC_PISC_A	Tissue	FB_2020FTC_PISC	20.2	102.2	10/26/2020
Commo Road - Non Tidal	38.74776, -76.84507	Composite Species 2 - Redbreast Sunfish	PIS0134	2020FTC_PISC_B	Tissue	FB_2020FTC_PISC	15.16	54.4	10/26/2020

Lab Sample ID		L2047407-06	L2047407-12	L2047407-12
Sample Station		2020FTC_PISC_A	2020FTC_PISC_B	2020FTC_PISC_B
Collection Date		10/26/2020	10/26/2020	10/26/2020
Site Description		Piscataway - Commo Road	Piscataway - Commo Road	Piscataway - Commo Road
Species Common Name		Yellow Bullhead Catfish	Redbreast Sunfish	Redbreast Sunfish
Units	Footnote	ug/kg	ug/kg	ug/kg
Perfluorobutanesulfonic Acid (PFBS)	4	ND	ND	•
Perfluorohexanoic Acid (PFHx A)	3	ND	ND	•
Perfluoroheptanoic Acid (PFHpA)	3	ND	ND	•
Perfluorohexanesulfonic Acid (PFHxS)	3	1.06	2.44	• 2.44
Perfluorooctanoic Acid (PFOA)	3	ND	ND	•
Perfluorononanoic Acid (PFNA)	3	ND	ND	•
Perfluorooctanesulfonic Acid (PFOS)	5	20.00	417.00	**233.00**
Perfluorodecanoic Acid (PFDA)	3	ND	1.86	• 1.86
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	4	ND	ND	•
PerfluorouND1ecanoic Acid (PFUnA)	4	ND	2.71	• 2.71
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	4	ND	ND	•
Perfluorododecanoic Acid (PFDoA)	4	ND	3.65	• 3.65
Perfluorotridecanoic Acid (PFTrDA)	4	1.05	3.30	• 3.30
Perfluorotetradecanoic Acid (PFTA)	4	1.04	ND	•
Total PFAS		23.15	430.96	246.96
Data Qualifiers			E	Replicate

ND - Non Detect
• - Not Analyzed or quanitifed in replicate run.
3 - Reporting limits ranging from lowest 0.221 to highest 0.244
4 - Reporting limits ranging from lowest 0.442 to highest 0.488
5 - Reporting limits ranging from lowest 0.221 to highest 2.210
Data Qualifiers
E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.

Table 3: PFASs measured in Field Blanks and Trip Blanks (ng/l)

Lab Sample ID		L2127169-01	L2127169-02	L2127169-03	L2127169-10	L2127169-11	L2127169-12	L2127169-13	L2127169-14	L2127213-13	L2127213-27	L2127213-42	L2127213-43	L2128737-13	L2128737-14		
Sample Station		S1-TB5	S5-FB1	S6-FB1	S1-TB6	S7-FB1	S8-FB1	S9-FB1	S10-FB1	S3-FB1	S6-FB1	S1-FB1	TB-1	S7-FB1	TB-4	LCMSMS-ID	LCMSMS-ID
Collection Date		5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/17/2021	5/20/2021	5/14/2021	5/14/2021	5/26/2021	5/26/2021	6/2/2021	6/16/2021
Site Description	Footnote	Trip Blank for S5-FB1, S6-FB1, S6-W1, and S7-W1	Tidal Headwaters of Nanjemoy Creek	Non-Tidal Headwaters of Nanjemoy Creek	Trip Blank for S2-W1, S3-W1, S4-W1, S5-W1, S7-FB1, S8-FB1, S9-FB1, and S10-FB1	Windbrook Road Crossing	Commo Road - Non-Tidal	Woodyard Road Crossing	Colonial Lane	Commo Road - Non-Tidal	Tidal headwaters of Nanjemoy Creek	Tidal headwaters of Piscataway Creek	Trip Blank for S1-T1, S1-T2, S1-W1, and S1-FB1	Non Tidal waters of Nanjemoy Creek	Trip Blank for S7-T1, S7-T2, and S7-FB1	Method Blank Analysis	Method Blank Analysis
Units		ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l
Perfluorobutanesulfonic Acid (PFBS)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorohexanoic Acid (PFHx A)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoroheptanoic Acid (PFHpA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorohexanesulfonic Acid (PFHxS)	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorooctanoic Acid (PFOA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorononanoic Acid (PFNA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorooctanesulfonic Acid (PFOS)	2	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorodecanoic Acid (PFDA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
PerfluorouNDecanoic Acid (PFUnA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorododecanoic Acid (PFDoA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorotridecanoic Acid (PFTrDA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorotetradecanoic Acid (PFTA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PFAS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

ND - Non Detect
1 - Reporting limits ranging from lowest 1.77 to highest 2.05
2 - Reporting limits ranging from lowest 1.770 to highest 50.000

Table 4: Sample Location Summary Table

Location	Position	Collection Reference	Site Reference	Sample ID	Sample Type	Field Blanks	Avg Length (cm)	Avg Weight (g/lbs.)	Collection Date	Deliver to Lab
Tidal headwaters of Piscataway Creek	38.69522, -77.00623	Water Sample		S1-W1	Water	S1-FB1			5/14/2021	5/21/2021
Tidal headwaters of Piscataway Creek	38.69522, -77.00623	Composite Species 1 - Largemouth Bass		S1-T1	Tissue	S1-FB1	39.9	910.8	5/14/2021	5/21/2021
Tidal headwaters of Piscataway Creek	38.69522, -77.00623	Composite Species 2 - Blue Catfish		S1-T2	Tissue	S1-FB1	47.38	1081	5/14/2021	5/21/2021
Windbrook Road Crossing	38.70933, -76.93954	Water Sample		S2-W1	Water	S2-FB1				5/21/2021
Commo Road - Non Tidal	38.74618, -76.84636	Composite Species 1 - Redbreast Sunfish		S3-T1	Tissue	S3-FB1	15.5	72.8	5/17/2021	5/21/2021
Commo Road - Non Tidal	38.74618, -76.84636	Composite Species 2 - Yellow Bullhead Catfish		S3-T2	Tissue	S3-FB1	17.7	75.8	5/17/2021	5/21/2021
Commo Road - Non Tidal	38.74618, -76.84636	Water Sample		S3-W1	Water	S3-FB1			5/17/2021	5/21/2021
Woodyard Road Crossing	38.78536, -76.84388	Water Sample		S4-W1	Water	S4-FB1			5/18/2021	5/21/2021
Colonial Lane	38.78866, -76.86529	Water Sample		S5-W1	Water	S5-FB1			5/18/2021	5/21/2021
Tidal headwaters of Nanjemoy Creek	38.44992, -77.15417	Water Sample	Control	S6-W1	Water	S6-FB1			5/20/2021	5/21/2021
Tidal headwaters of Nanjemoy Creek	38.44992, -77.15417	Composite Species 1 - Bluegill	Control	S6-T1	Tissue	S6-FB1	16.7	107.4	5/20/2021	5/21/2021
Tidal headwaters of Nanjemoy Creek	38.44992, -77.15417	Composite Species 2 - Blue Catfish	Control	S6-T2	Tissue	S6-FB1	48.4	1073.2	5/20/2021	5/21/2021
Non Tidal waters of Nanjemoy Creek	38.42201, -77.21040	Water Sample	Control	S7-W1	Water	S7-FB1			5/26/2021	5/28/2021
Non Tidal waters of Nanjemoy Creek	38.42201, -77.21040	Composite Species 1 - Redbreast Sunfish	Control	S7-T1	Tissue	S7-FB1	14.9	60.2	5/26/2021	5/28/2021
Non Tidal waters of Nanjemoy Creek	38.42201, -77.21040	Composite Species 2 - Yellow Bullhead Catfish	Control	S7-T2	Tissue	S7-FB1	21.1	142.2	5/26/2021	5/28/2021

Field Blanks	One with each site collected	S1-FB1,S2-FB1,S3-FB1,S4-FB1,S5-FB1,S6-FB1,S7-FB1			Water	7
Trip Blanks	One with each "trip"	TB-1,TB-2,TB-3,TB-4			Water	4
Replicates	Done in Lab	Water Sample	Lab Sample		Water	1
Replicates	Done in Lab	Tissue Replicate	Lab Sample		Tissue	1
NIST Water Sample	Done in Lab	Water Sample	Lab Sample		Water	1
NIST Tissue Sample	Done in Lab	Tissue Replicate	Lab Sample		Tissue	1

Media	Count
Tissue	10
Water	20

Table 5: PFASs measured in surface water (ng/l)

Lab Sample ID		L2127169-04	L2127169-05	L2127169-06	L2127169-07	L2127169-08	L2127169-08 RE	L2127169-09	L2127169-09 RE	L2127213-41
Sample Station		S6-W1	S7-W1	S2-W1	S3-W1	S4-W1	S4-W1 RE	S5-W1	S5-W1 RE	S1-W1
Collection Date		5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/18/2021	5/14/2021
Site Description	Footnote	Tidal Headwaters of Nanjemoy Creek	Non-Tidal Headwaters of Nanjemoy Creek	Windbrook Road Crossing	Commo Road - Non-Tidal	Woodyard Road Crossing	Woodyard Road Crossing	Colonial Lane	Colonial Lane	Tidal headwaters of Piscataway Creek
Units		ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l
Perfluorobutanesulfonic Acid (PFBS)	1	ND	ND	10.6	39.4	80.8	80.8	108	108	6.89
Perfluorohexanoic Acid (PFHx A)	1	2.24	ND	38.4	133	276	276	353	353	24
Perfluoroheptanoic Acid (PFHpA)	1	ND	ND	17.3	40.2	75.5	75.5	89.7	89.7	10.4
Perfluorohexanesulfonic Acid (PFHxS)	2	ND	ND	93.9	424	889	**827**	1200	**1120**	62.4
Perfluorooctanoic Acid (PFOA)	1	1.97	ND	50.8	147	298	298	404	404	27.1
Perfluorononanoic Acid (PFNA)	1	ND	ND	3.39	10.1	20.4	20.4	17.8	17.8	2.7
Perfluorooctanesulfonic Acid (PFOS)	2	2.56	ND	96.1	478	1120	**988**	1280	**1100**	73.6
Perfluorodecanoic Acid (PFDA)	1	ND	ND	ND	ND	2.67	2.67	ND	ND	ND
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND
PerfluoroND1ecanoic Acid (PFUnA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorododecanoic Acid (PFDoA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorotridecanoic Acid (PFTrDA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorotetradecanoic Acid (PFTA)	1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Total PFAS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Data Qualifiers		F				E	Replicate	E	Replicate	
PFOA + PFOS	ng/L	4.53	ND	146.9	625	1418	1286	1684	1504	100.7
Risk Based Recreational Swimming Screening Concentration PFOA + PFOS (Moderate Risk/Intensive Risk	ng/L	17,500 8,770	17,500 8,770	17,500 8,770	17,500 8,770	17,500 8,770	17,500 8,770	17,500 8,770	17,500 8,770	17,500 8,770
PFBS	ng/L	ND	ND	10.6	39.4	80.8	80.8	108	108	6.89
Risk Based Recreational Swimming Screening Concentration PFBS (Moderate Risk/Intensive Risk)	ng/L	26,200 13,100	26,200 13,100	26,200 13,100	26,200 13,100	26,200 13,100	26,200 13,100	26,200 13,100	26,200 13,100	26,200 13,100

ND - Non Detect
1 - Reporting limits ranging from lowest 1.77 to highest 2.05
2 - Reporting limits ranging from lowest 1.770 to highest 50.000
• - Not Analyzed

Data Qualifiers
E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
F - The ration of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

Table 6: PFASs measured in fish tissue (ug/kg)

		L2127213-06	L2127213-06 D	L2127213-12	L2127213-20	L2127213-26	L2127213-34	L2127213-40	L2128737-06	L2128737-12
Sample Station		S3-T1	S3-T1	S3-T2	S6-T1	S6-T2	S1-T1	S1-T2	S7-T1	S7-T2
Collection Date		5/17/2021	5/17/2021	5/17/2021	5/20/2021	5/20/2021	5/14/2021	5/14/2021	5/26/2021	5/26/2021
Site Description	Footnote	Commo Road - Non Tidal	Commo Road - Non Tidal	Commo Road - Non Tidal	Tidal headwaters of Nanjemoy Creek	Tidal headwaters of Nanjemoy Creek	Tidal headwaters of Piscataway Creek	Tidal headwaters of Piscataway Creek	Non tidal waters of Nanjemoy Creek	Non tidal waters of Nanjemoy Creek
Species Common Name		Redbreast Sunfish	Redbreast Sunfish	Yellow Bullhead Catfish	Bluegill	Blue Catfish	Largemouth Bass	Blue Catfish	Redbreast Sunfish	Yellow Bullhead Catfish
Units		ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg	ug/kg
Perfluorobutanesulfonic Acid (PFBS)	4	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorohexanoic Acid (PFHx A)	3	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluoroheptanoic Acid (PFHpA)	3	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorohexanesulfonic Acid (PFHxS)	3	0.822	0.822	0.762	ND	ND	0.512	ND	ND	ND
Perfluorooctanoic Acid (PFOA)	3	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorononanoic Acid (PFNA)	3	0.374	0.374	ND	ND	ND	ND	ND	ND	ND
Perfluorooctanesulfonic Acid (PFOS)	5	359.00	**231.00**	24.7	5.21	1.35	94.2	2.52	5.20	3.30
Perfluorodecanoic Acid (PFDA)	3	1.57	1.57	0.282	0.360	ND	1.75	0.403	0.504	0.360
N-Methyl Perfluorooctanesulfonamidoacetic Acid (NMeFOSAA)	4	ND	ND	ND	ND	ND	ND	ND	ND	ND
PerfluorouND1ecanoic Acid (PFUnA)	4	2.58	2.58	0.509	0.604	ND	1.69	0.590	1.10	ND
N-Ethyl Perfluorooctanesulfonamidoacetic Acid (NEtFOSAA)	4	ND	ND	ND	ND	ND	ND	ND	ND	ND
Perfluorododecanoic Acid (PFDoA)	4	3.97	3.97	0.898	ND	ND	1.26	ND	0.706	ND
Perfluorotridecanoic Acid (PFTrDA)	4	3.45	3.45	1.04	ND	ND	0.77	ND	1.43	0.472
Perfluorotetradecanoic Acid (PFTA)	4	3.08	3.08	0.987	ND	ND	0.502	ND	0.653	ND
Total PFAS		374.85	246.85	29.18	6.17	1.35	100.69	3.51	9.59	4.13
Data Qualifiers		E	Replicate	F		F	F	F	F	F
Fish Tissue Screening Concentration for PFOS General Population (76 kg) - 4 Meals/month	ug/kg	73	73	73	73	73	73	73	73	73
Fish Tissue Screening Concentration for PFOS Women Child Bearing Age (67 kg) - 4 Meals/month	ug/kg	64	64	64	64	64	64	64	64	64
Fish Tissue Screening Concentration for PFOS Children (14.5 kg) - 4 Meals/month	ug/kg	37	37	37	37	37	37	37	37	37

Note: All Screening Concentration values are for cooked fish tissue
ND - Non Detect
• - Not Analyzed
3 - Reporting limits ranging from lowest 0.221 to highest 0.244
4 - Reporting limits ranging from lowest 0.442 to highest 0.488
5 - Reporting limits ranging from lowest 0.221 to highest 2.210

Data Qualifiers
E - Concentration of analyte exceeds the range of the calibration curve and/or linear range of the instrument.
F - The ration of quantifier ion response to qualifier ion response falls outside of the laboratory criteria. Results are considered to be an estimated maximum concentration.

Table 7: Surface Water PFOA + PFOS Screening Concentrations

Recreational Scenario (All Populations)	**Exposure duration (yrs.)**	**Exposure frequency (days/yr.)**	**Exposure time (hrs. day)**	**Recreational Swimming Screening Concentration PFOA+PFOS/(PFBS) (ng/L)**
Swimming in surface water **moderate**	26	26 (2 days a week, 13 weeks)	2	**17,500/(26,200)**
Swimming in surface water **intensive**	26	52 (2 days a week, 26 weeks)	2	**8,770/(13,100)**

Table 8: Fish Tissue (Cooked Meat Only) Screening Concentrations

Site-Specific Fish Consumption Screening Concentrations

Population	Consumption Rate (mg-day)	Approximate Meals per Month (8-ounce meal adult, 3-ounce child)	Approximate Meals Per Year	Fish Tissue (cooked) Screening Concentration (ug/kg) for PFOS
General Population (76 kg)	59,650	8	96	37
Women Child Bearing Age (67 kg)	59,650	8	96	33
Children (14.5 kg)	22,370	8	96	19
General Population (76 kg)	29,825	4	48	73
Women Child Bearing Age (67 kg)	29,825	4	48	64
Children (14.5 kg)	11,185	4	48	37
General Population (76 kg)	7,456	1	12	291
Women Child Bearing Age (67 kg)	7,456	1	12	257
Children (14.5 kg)	2,796	1	12	149

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[1] *Fish consumption screening concentration derivations within the MDE Fish and Shellfish Program include a 30 % reduction in contaminant concentration in the fish due to trimming and cooking losses.*

Figure 1: Site Map – Piscataway Creek Overview

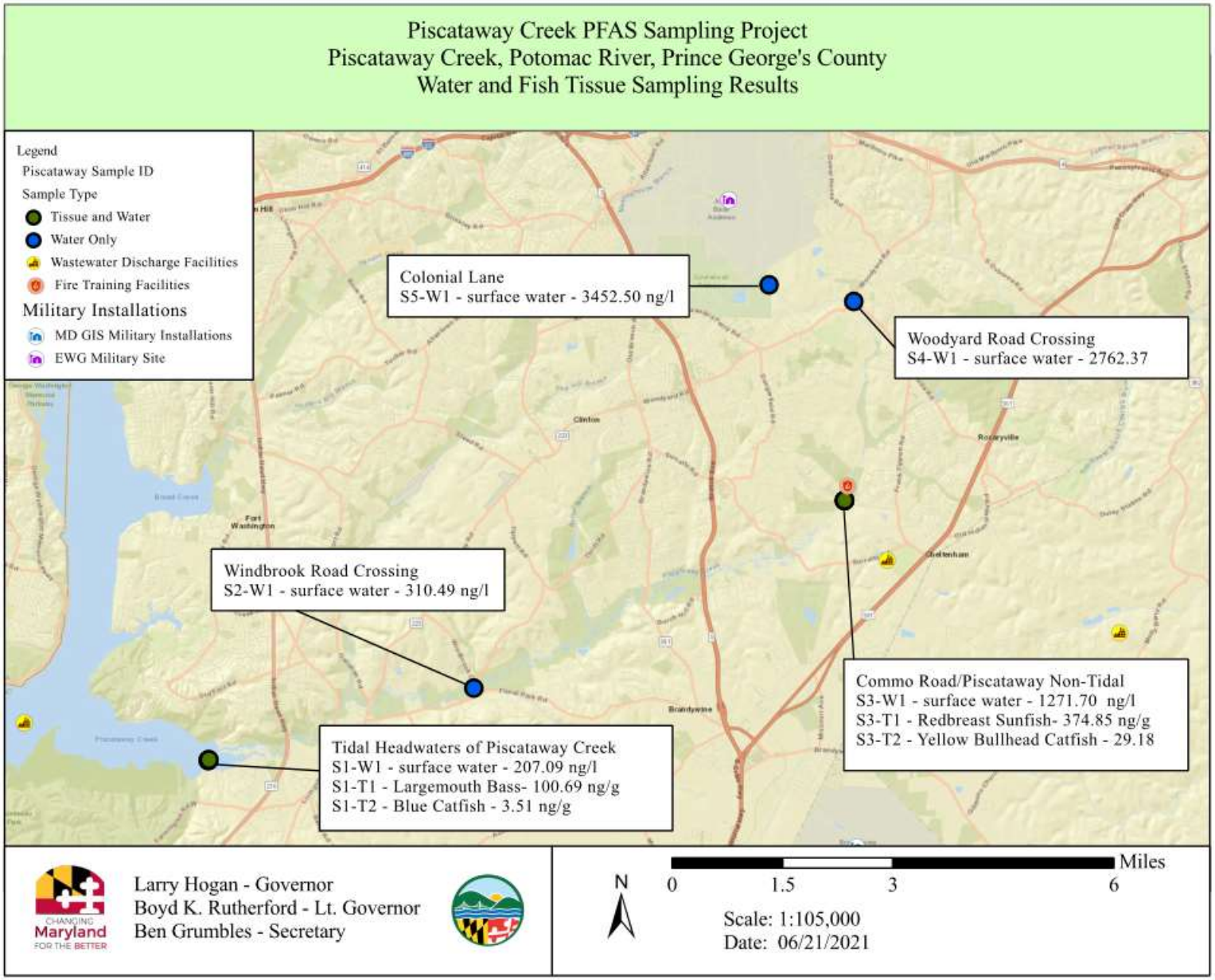

Figure 2: Site Map – Nanjemoy Creek – Reference Site